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COLLISION TYPE JUDGING DEVICE AND COLLISION TYPE JUDGING METHOD

[Shototsukeitai hanbetsusochi oyobi shototsukeitai hanbetsuhoho]

Katsuji Imai et al.

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INVENTORS	(72):	Katsuji Imai et al.
APPLICANTS	(71):	000003207
		Toyota Motor Corporation
		000003609
		Toyota Central Research Lab
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Claims

1. A collision type judging device that determines the collision type of a vehicle, having

a deceleration detecting means that is provided in the front and at the center of the passenger compartment of said vehicle to detect the deceleration,

a time integration calculating means that calculates the time integration value of the detected deceleration, and

a collision type judging means that determines the collision type based on the trajectory of the calculated time integration value of the deceleration with respect to time.

2. The collision type judging device cited in Claim 1, wherein said collision type judging means judges the collision type based on the trajectory of the time differentiation of the time integration value of said deceleration with respect to time.

3. The collision type judging device cited in Claim 2, wherein said collision type judging means judges the collision type as head-on collision when the trajectory of the time differentiation of the time integration value of said deceleration with respect to time increases monotonically.

4. The collision type judging device cited in Claim 1, wherein said collision type judging means judges the collision type as head-on collision when the trajectory of the time differentiation of the time integration value of said deceleration with respect to time can be approximated by a quadratic curve.

5. The collision type judging device cited in Claim 4, wherein

said collision type judging means has

a normalization means that normalizes the trajectory of the time integration value of said deceleration with respect to time,

an error calculating means that calculates the error between the normalized trajectory and the normalized quadratic curve, and

a head-on collision judging means that determines whether the collision type is head-on collision based on the calculated error.

6. The collision type judging device cited in Claim 5, wherein said error calculating means calculates the square root of sum of squares of the deviations at prescribed positions between said normalized trajectory and the normalized quadratic curve.

7. The collision type judging device cited in Claim 5 or 6, wherein said head-on collision judging means judges the collision type as head-on collision when the calculated error is less than or equal to a prescribed value.

8. A collision type judging method that determines the collision type of a vehicle, wherein (a) the time integration value of the deceleration in the front and at the center of the passenger compartment of the vehicle is calculated, and (b) the collision type is judged based on the trajectory of the calculated time integration value of the deceleration with respect to time.

9. The collision type judging method cited in Claim 8, wherein in step (b), the collision type is judged as head-on collision if the trajectory of the time differentiation of the time integration value of said deceleration with respect to time increases monotonically.

10. The collision type judging method cited in Claim 8, wherein in step (b), the collision type is judged as head-on collision if the trajectory of the time differentiation of the time integration value of said deceleration with respect to time can be approximated by a quadratic curve.

11. The collision type judging method cited in Claim 10, wherein

said step (b) has the following steps:

(b1) normalizing the trajectory of the time integration value of said deceleration with respect to time,

(b2) calculating the error between the normalized trajectory and the normalized quadratic curve, and

(b3) determining whether the collision type is head-on collision based on the calculated error.

12. The collision type judging method cited in Claim 11, wherein

in step (b2), the square root of sum of squares of the deviations at prescribed positions between said normalized trajectory and the normalized quadratic curve is calculated as said error, and

in step (b3), the collision type is judged as head-on collision when the calculated error is less than or equal to a prescribed value.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention relates to a collision type judging device and a collision type judging method. More specifically, the present invention relates to a collision type judging device and a collision type judging method that judge the collision type of a vehicle.

[0002]

Prior art

The timing for starting airbag device or the passenger protective device installed in a vehicle is adjusted based on the collision type. Collision type is classified as full-lap collision with the vehicle colliding on the entire front surface, offset collision with the vehicle colliding on one side in the front, or oblique collision with the vehicle colliding at any angle. Full-lap collision can be further classified as head-on collision with the vehicle colliding on the entire front surface, pole collision with the central part on the front surface of the vehicle colliding with an object, for example, a pole, and underride collision with the vehicle crushed under the rear part of a truck or the like. Also, offset collision can be

further classified as ORB (offset rigid barrier) with the vehicle colliding with a rigid object with no deformation and ODB (offset deformable barrier) with the vehicle colliding with a deformable object.

[0003]

Problems to be solve by the invention

Since the difference in the collision type is usually reflected in the direction or amount of passenger movement during collision and the timing of this movement, it is believed that the collision type can be judged and used to start a more appropriate passenger protective device with more reliable timing. The applicant has proposed a device used for judging collision type. In this case, full-lap collision and offset collision can be effectively identified based on the difference or ratio of the decelerations detected by G sensors (satellite sensors) provided on the left and right in the front of a vehicle (Japanese Patent Application No. Hei 8[1996]-326180).

[0004]

An objective of the collision type judging device and the collision type judging method of the present invention is to judge the collision type of a vehicle more correctly. Another objective of the collision type judging device and the collision type judging method of the present invention is to determine whether the collision type of a vehicle is head-on collision more correctly. Yet another objective of the collision type judging device and the collision type judging method of the present invention is to judge the collision type of a vehicle more quickly.

[0005]

Means to solve the problems and function/effect thereof

The collision type judging device and the collision type judging method of the present invention adopt the following means in order to realize at least part of the aforementioned objectives.

[0006]

The collision type judging device disclosed in the present invention is used to determine the collision type of a vehicle. It has a deceleration detecting means that is provided in the front and at the center of the passenger compartment of the aforementioned vehicle to detect the deceleration, a time integration calculating means that calculates the time integration value of the detected deceleration, and a collision type judging means that determines the collision type based on the trajectory of the calculated time integration value of the deceleration with respect to time.

[0007]

In the collision type judging device disclosed in the present invention, the time integration value calculating means calculates the time integration value of the deceleration detected by the deceleration detecting means disposed in the front and at the center of the passenger compartment of the vehicle. The collision type judging means judges the collision type based on the trajectory of the calculated time integration value of the deceleration with respect to time. It is possible to judge the collision type based on the difference in the trajectory because the trajectory of the time integration value of the deceleration with respect to time varies depending on the collision type, especially for head-on collision of the vehicle.

[0008]

In the collision type judging device disclosed in the present invention, the aforementioned collision type judging means can also judge the collision type based on the trajectory of the time differentiation of the time integration value of the aforementioned deceleration with respect to time. As described above, the difference in the collision type of the vehicle is reflected in the trajectory of the time integration value of the deceleration with respect to time. However, since it is also reflected in the trajectory of its variation rate, it is also possible to judge the collision type based on the trajectory of the time differentiation of the integration value of the deceleration with respect to time. In this collision type judging device, the aforementioned collision type judging means can also judge the collision type as head-on collision when the trajectory of the time differentiation of the integration value of the deceleration with respect to time increases monotonically.

[0009]

In the collision type judging device disclosed in the present invention, the aforementioned collision type judging means can also judge the collision type as head-on collision when the trajectory of the time differentiation of the time integration value of the aforementioned deceleration with respect to time can be approximated by a quadratic curve. In the case of head-on collision among the collision types of a vehicle, the trajectory of the time integration value of the deceleration with respect to time can usually be approximated by a quadratic curve, while other collision types usually cannot be approximated by a quadratic curve. It is possible to take advantage of this fact to determine whether a collision type is head-on collision. In the addition to the concept of curve, said "quadratic curve" also includes quadratic equation.

[0010]

In the collision type judging device that makes its judgment depending on approximation to a quadratic curve, the aforementioned collision type judging means can also have a normalization means that normalizes the trajectory of the time integration value of said deceleration with respect to time, an error calculating means that calculates the error between the normalized trajectory and the normalized quadratic curve, and a head-on collision judging means that determines whether the collision type is head-on collision based on the calculated error. In this way, it is possible to use the approximation degree with quadratic wave objectively to judge the collision type. In this collision type judging device, the aforementioned error calculating means can calculate the square root of sum of squares of the deviations at prescribed positions between said normalized trajectory and the normalized quadratic curve as the aforementioned error. The aforementioned head-on collision judging means can judge the collision type as head-on collision when the calculated error is less than or equal to a prescribed value. In this way, it is possible to judge the collision type objectively and quickly.

[0011]

The collision type judging method disclosed in the present invention determines the collision type of a vehicle. This method has the following steps: (a) the time integration value of the deceleration in the front and at the center of the passenger compartment of the vehicle is calculated, and (b) the collision type is judged based on the trajectory of the calculated time integration value of the deceleration with respect to time.

[0012]

In the collision type judging method disclosed in the present invention, the collision type can be judged by taking advantage of the fact that the trajectory of the time integration value of the deceleration with respect to time varies depending on the collision type of the vehicle, especially depending on whether a collision is head-on collision.

[0013]

In the collision type judging method disclosed in the present invention, in step (b), the collision type can be judged as head-on collision if the trajectory of the time differentiation of the time integration value of the aforementioned deceleration with respect to time increases monotonically. The difference in the collision type of the vehicle is reflected in the trajectory of the time integration value of the deceleration with respect to time. However, since it is also reflected in the trajectory of its variation rate, it is also possible to judge the collision type based on the trajectory of the time differentiation of the integration value of the deceleration with respect to time.

[0014]

In the collision type judging method disclosed in the present invention, in step (b), the collision type can also be judged as head-on collision if the trajectory of the time differentiation of the time integration value of the aforementioned deceleration with respect to time can be approximated by a quadratic curve. In the case of head-on collision among the collision types of a vehicle, the trajectory of the time integration value of the deceleration with respect to time can usually be approximated by a quadratic curve, while other collision types usually cannot be approximated by quadratic curve. It is possible to take advantage of this fact to determine whether a collision type is head-on collision. In this collision

type judging method, the aforementioned step (b) can also have the following steps: (b1) normalizing the trajectory of the time integration value of the aforementioned deceleration with respect to time, (b2) calculating the error between the normalized trajectory and the normalized quadratic curve, and (b3) determining whether the collision type is head-on collision based on the calculated error. In this way, it is possible to use the approximation degree with quadratic wave objectively to judge the collision type. Moreover, in the collision type judging method disclosed in the present invention, in step (b2), the square root of sum of squares of the deviations at prescribed positions between the aforementioned normalized trajectory and the normalized quadratic curve can be calculated as the aforementioned error. In step (b3), the collision type can be judged as head-on collision when the calculated error is less than or equal to a prescribed value.

[0015]

Embodiment of the invention

In the following, the embodiment of the present invention will be explained with reference to an application example. Figure 1 is a configuration diagram illustrating the functional blocks of the schematic configuration of collision type judging device 20 as an application example of the present invention. Figure 2 is a configuration diagram schematically illustrating the hardware configuration of collision type judging device 20 disclosed in the application example. Figure 3 is a diagram explaining the state when collision type judging device 20 disclosed in the application example is mounted in a vehicle 10.

[0016]

As shown in Figures 1 and 3, collision type judging device 20 disclosed in the application example has floor sensor 22 that is installed near the central console of vehicle 10 to detect deceleration G, integration calculating part 28 that receives the input of deceleration G detected by floor sensor 22 and calculates the time integration value VG of deceleration G, and collision type judging part 30 that judges the collision type based on the trajectory of the time integration value VG of deceleration G with respect to time. Collision type judging part 30 has normalizing part 32 that normalizes the trajectory of the time integration value VG of deceleration G with respect to time, error calculating part 34 that calculates the error between the normalized trajectory and a quadratic curve, and judging part 36 that determines whether the collision type is head-on collision based on the calculated error.

[0017]

As shown in Figure 2, the hardware configuration of collision type judging device 20 disclosed in the application example comprises floor sensor 22 and microcomputer 40 using CPU 42 as the center. Microcomputer 40 has ROM 44 used for storing the processing program, RAM 46 used for temporarily storing data, and input/output processing circuit (I/O) 48 in addition to CPU 42. For each part of collision type judging device 20 disclosed in the application example and shown in Figure 1, the software and the hardware function integrally when the processing program stored in ROM 44 is started. In order to determine whether the collision is of another type, such as full-lap collision or offset collision, as shown in Figure 2, left and right front sensors 24, 26 are installed in front (crush zone) of the left and right side members of vehicle 10 to detect deceleration.

[0018]

In the following, the operation of collision type judging device 20 disclosed in the application example and having the aforementioned configuration will be explained. Figure 4 is a flow chart illustrating an example of the head-on collision judging routine executed by microcomputer 40 of collision type judging device 20 disclosed in the application example. This routine is executed when deceleration G detected by floor sensor 22 exceeds a prescribed value Gth.

[0019]

When the head-on collision judging routine is executed, the CPU 42 of microcomputer 40 first reads deceleration G detected by floor sensor 22 (step S100). Then, the time integration value VG of read deceleration G is calculated with the period from the time when this routine is started to the current time as the integration interval (step S102). After that, the paired data of the calculated time integration value VG and the current time t are written in a prescribed region of RAM 46 (step S104). Then, the calculated time integration value VG is compared with threshold value Vth (step S106). If time integration value VG is less than threshold value Vth, the process returns to step S100 for reading deceleration G.

[0020]

On the other hand, if deceleration G is greater than or equal to threshold value Vth, the paired data of the time integration value VG and the current time t stored in the prescribed region of RAM 46 are read out and normalized (step S108). More specifically, normalization is performed by dividing each time integration value VG by threshold value Vth to calculate normalized time integration value VG/Vth and dividing current time t by time T, at which the time integration value VG becomes greater than or equal

to threshold value Vth, to calculate normalized time t/T. Figure 5 is a diagram explaining an example of the trajectory of time integration value VG with respect to time t. Figure 6 is a diagram explaining an example of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T corresponding to the trajectory shown in Figure 5. As shown in Figure 6, since time integration value VG and time t are normalized, the starting point of the trajectory is the origin, and the ending point of the trajectory becomes (1, 1).

[0021]

Then, error E of the normalized trajectory with respect to quadratic curve is calculated (step S110). Figure 7 shows an example of the method for calculating error E. In this figure, curve A is a quadratic curve, while curve B is the normalized trajectory. Error E is calculated as the square root of the sum of squares of deviations e1, e2, e3 between the normalized trajectory and the quadratic curve at the times that equally divide normalized time t/T into four parts as shown in Figure 7 in this application example (equation (1)).

[0022]

[Equation 1]

$$E=\sqrt{e1^2+e2^2+e3^2} \qquad (1)$$

[0023]

In the following, the reason that whether the collision type of vehicle 10 can be judged as head-on collision depending on error E will be explained. Figure 8 is a diagram explaining an example of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T when a

head-on collision occurs. Figure 9 is a diagram explaining an example of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T when a full-lap collision other than head-on collision occurs, for example, pole collision with the vehicle colliding with a pole or underride collision with the vehicle crushed under a larger vehicle. Curve A in Figures 8 and 9 is a quadratic curve. Curve C in Figure 8 is the normalized trajectory when head-on collision occurs. Curve D in Figure 9 is the normalized trajectory when a full-lap collision other than head-on collision occurs. As can be seen from Figures 8 and 9, the normalized trajectory when head-on collision occurs is close to the quadratic curve, while the trajectory in the case of the collision other than the head-on collision significantly deviates from the quadratic curve. Consequently, it is possible to determine whether the collision type is head-on collision depending on whether the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T can be approximated by a quadratic curve. In this application example, as shown in Figure 7, the approximation degree is derived as error E calculated as the square root of the sum of squares of the deviations between the trajectory and the quadratic curve in three places. That is, if error E is small, the collision type is judged as head-on collision. If error E is large, the collision type is judged as collision other than head-on collision.

[0024]

Now, in the head-on collision judging routine shown in Figure 4, when error E is calculated, error E is compared with threshold value Eth (step S112). If error E is less than or equal to threshold value Eth, the collision type is judged as head-on collision (step S114). If error E is greater than threshold value Eth, the collision type is judged as collision other than head-on collision (step S116). The routine is ended. Threshold value Eth is derived experimentally.

[0025]

By using collision type judging device 20 disclosed in the application example explained above, it is possible to accurately judge whether the collision type is head-on collision. Also, since the judgment is made only based on the calculation using deceleration G detected by floor sensor 22 installed near the central console of vehicle 10, the collision type can be judged by a simple configuration. In addition, since the collision type can be judged in the initial stage of the collision, the judgment result can be used effectively for the starting time or starting velocity of airbag device or other passenger protective device.

[0026]

In collision type judging device 20 disclosed in the application example, error E is calculated as the square root of the sum of squares of deviations e1, e2, e3 at three places that equally divide normalized time t/T into four parts. However, it is also possible to use the square root of the sum of squares of deviations at four or more places that equally divide normalized time t/T into five or more parts. Also, since only the approximation degree with quadratic curve is needed, it is also possible to derive the correlation value between the normalized trajectory and the quadratic curve and use it instead of error E. It is also possible to calculate the error as the sum of the absolute values of the deviations or the sum of squares of deviations. It is also possible to use a quadratic equation (equivalent quadratic equation) instead of the quadratic curve.

[0027]

In collision type judging device 20 disclosed in the application example, it is determined whether collision type is head-on collision depending on the approximation degree between the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T and the quadratic curve.

However, it is also possible to determine whether collision type is head-on collision depending on the approximation degree between the trajectory of non-normalized time integration value VG at time t and the quadratic curve. In this case, the quadratic equation expressing the quadratic curve has coefficients.

[0028]

In collision type judging device 20 disclosed in the application example, it is determined whether collision type is head-on collision depending on the approximation degree between the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T and the quadratic curve. However, it is also possible to determine whether collision type is head-on collision depending on the approximation degree with curves other than quadratic curve, such as cubic curve, quartic curve, or 2.5th order curve. Also, as shown in Figure 8, since the time variation rate of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T shows a tendency to monotonically increase when the collision type is head-on collision, it is also possible to determine whether collision type is head-on collision based on that time variation rate.

[0029]

The embodiment of the present invention has been explained based on the aforementioned application example. The present invention, however, is not limited to this application example. The present invention can also be embodied in various forms within scope of the gist of the present invention.

Brief description of the figures

Figure 1 is a configuration diagram illustrating the functional blocks of the schematic configuration of collision type judging device 20 as an application example of the present invention.

Figure 2 is a configuration diagram schematically illustrating the hardware configuration of collision type judging device 20 disclosed in the application example.

Figure 3 is a diagram explaining the state when collision type judging device 20 disclosed in the application example is mounted in a vehicle 10.

Figure 4 is a flow chart illustrating an example of the head-on collision judging routine executed by microcomputer 40 of collision type judging device 20 disclosed in the application example.

Figure 5 is a diagram explaining an example of the trajectory of time integration value VG with respect to time t.

Figure 6 is a diagram explaining an example of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T corresponding to the trajectory shown in Figure 5.

Figure 7 is a diagram explaining an example of the method for calculating error E.

Figure 8 is a diagram explaining an example of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T when a head-on collision occurs.

Figure 9 is a diagram explaining an example of the trajectory of the trajectory of normalized time integration value VG/Vth with respect to normalized time t/T when a collision other than head-on collision occurs.

Explanation of symbols

10 Vehicle

20 Collision type judging device

22 Floor sensor

24 Left front sensor

26 Right front sensor

28 Integration calculating part

30 Collision type judging part

32 Normalization part

34 Error calculating part

36 Judging part

40 Microcomputer

42 CPU

44 ROM

46 RAM

48 Input/output processing circuit

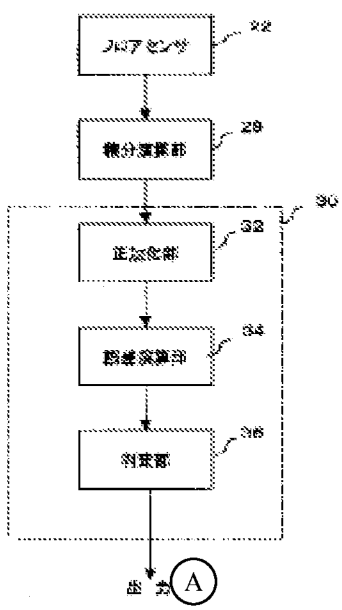

Figure 1

Key: A Output

22 Floor sensor

28 Integration calculating part

32 Normalization part

34 Error calculating part

36 Judging part

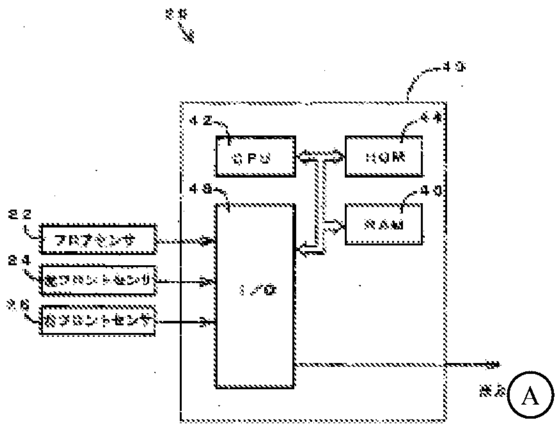

Figure 2

Key: A Output

22 Floor sensor

24 Left front sensor

26 Right front sensor

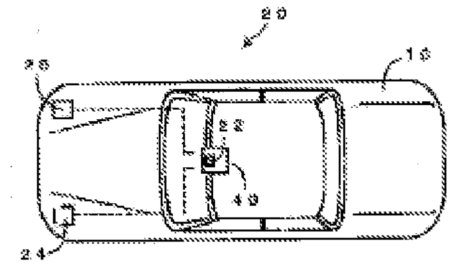

Figure 3

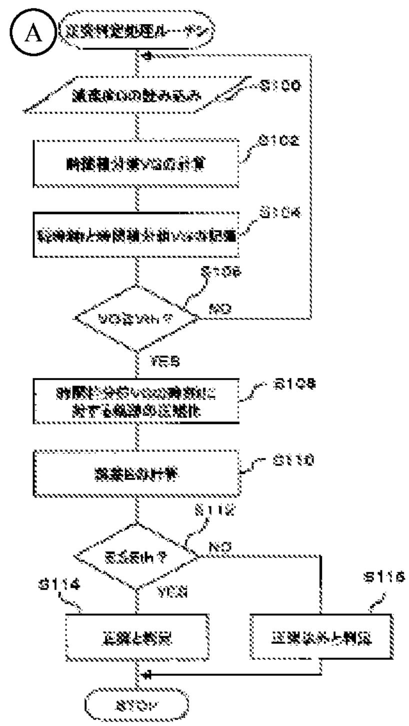

Figure 4

Key: A Head-on collision judging routine

S100 Read in deceleration G

S102 Calculate time integration value VG

S104 Store current time t and time integration value VG

S108 Normalize the trajectory of time integration value VG with respect to time t

S110 Calculate error E

S114 Collision type is judged as head-on collision

S116 Collision type is judged as collision other than head-on collision

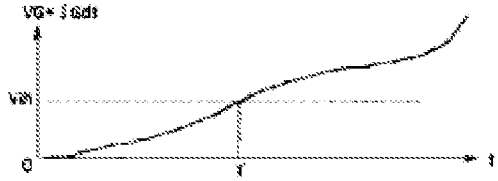

Figure 5

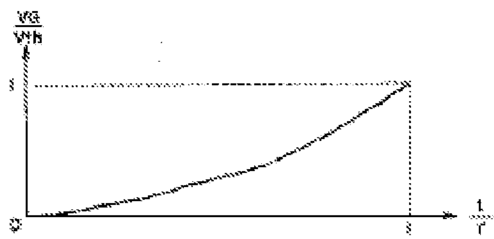

Figure 6

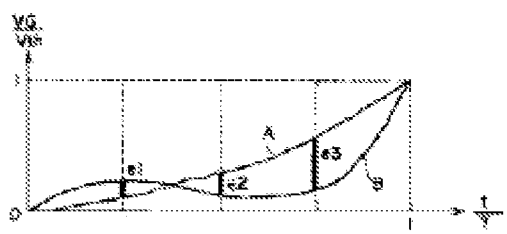

Figure 7

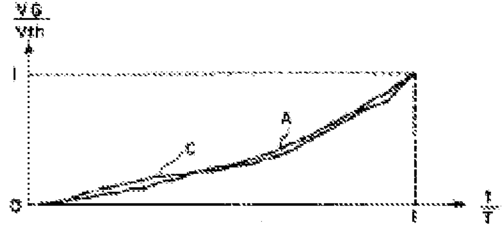

Figure 8

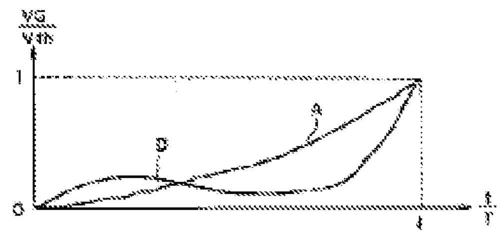

Figure 9